The Proton Driver and the Tevatron Collider

Tevatron now → 2009 and beyond (?)

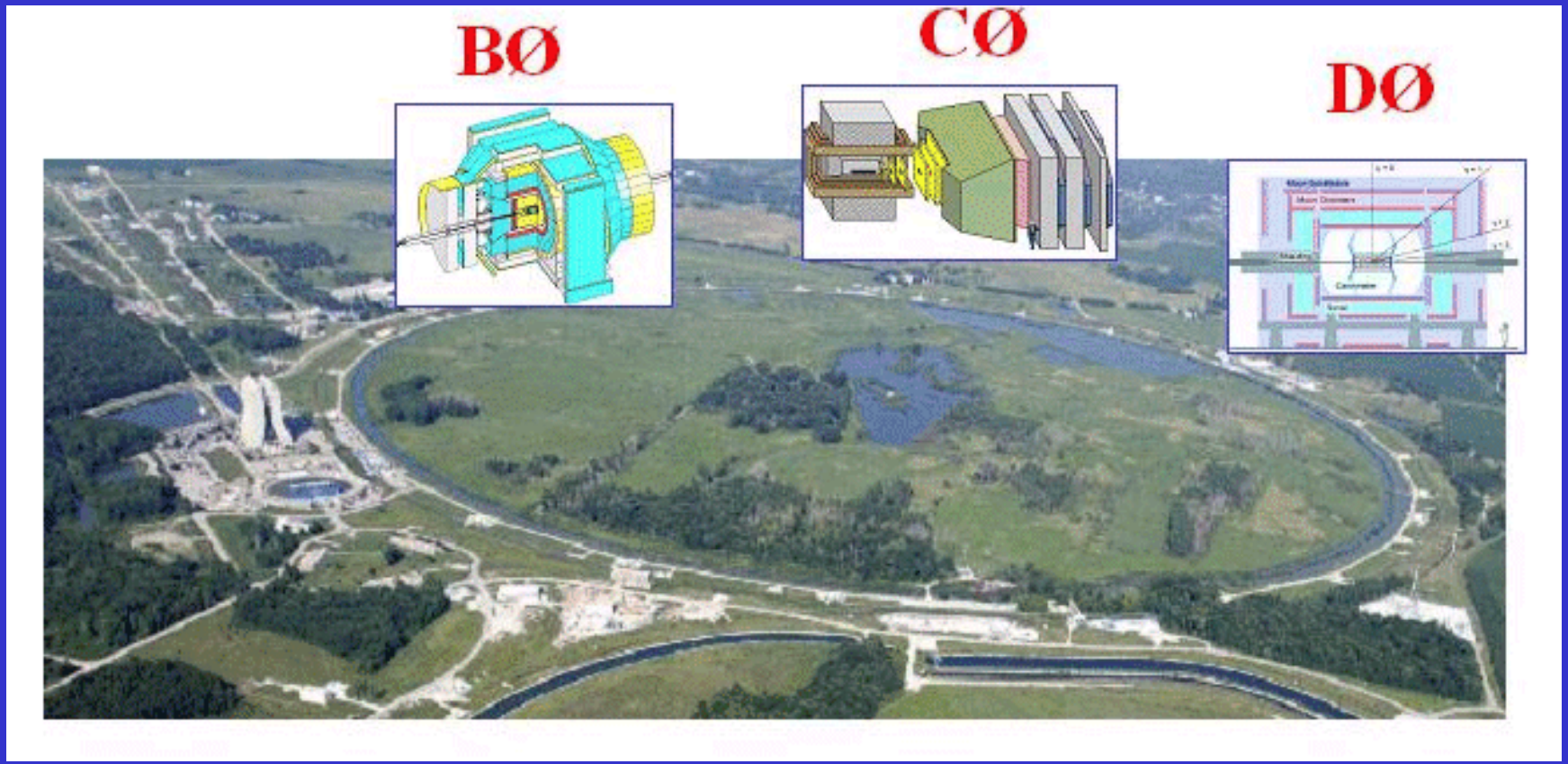
Experiments now and foreseen (or foresee-able?)

The GTeV idea, and "The Future of QCD at the Tevatron"

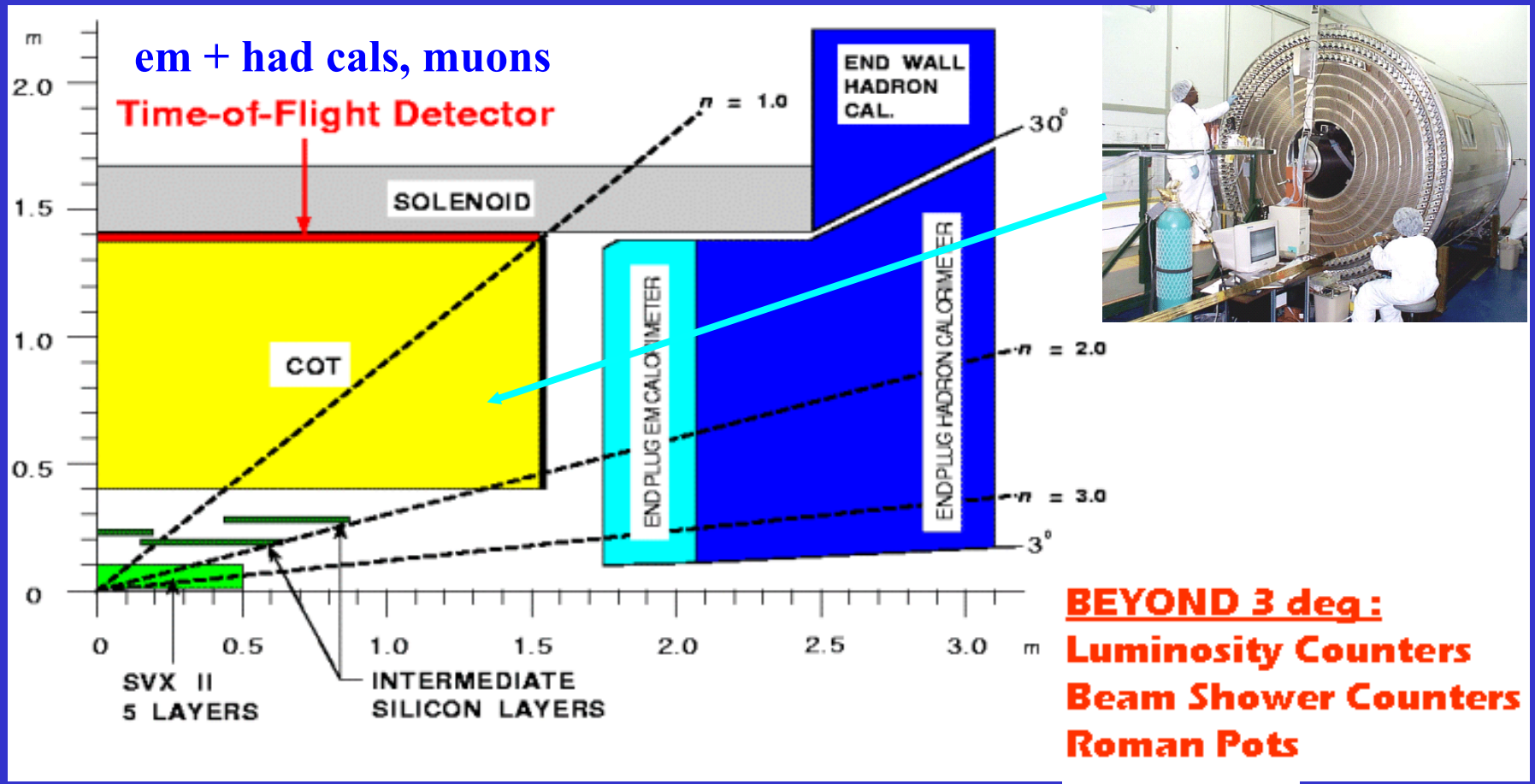
Is there a "physics shopping list" for 2004+ ?

Other long term uses for Tevatron or its tunnel

The Future of QCD at the Tevatron



CDF Detectors



BEYOND 3 deg :

Luminosity Counters

Beam Shower Counters

Roman Pots

MiniPlugs

Possible mini-upgrades for diffractive physics:

Precision roman pots on both beams

Fully instrument very forward region (< 3 deg)

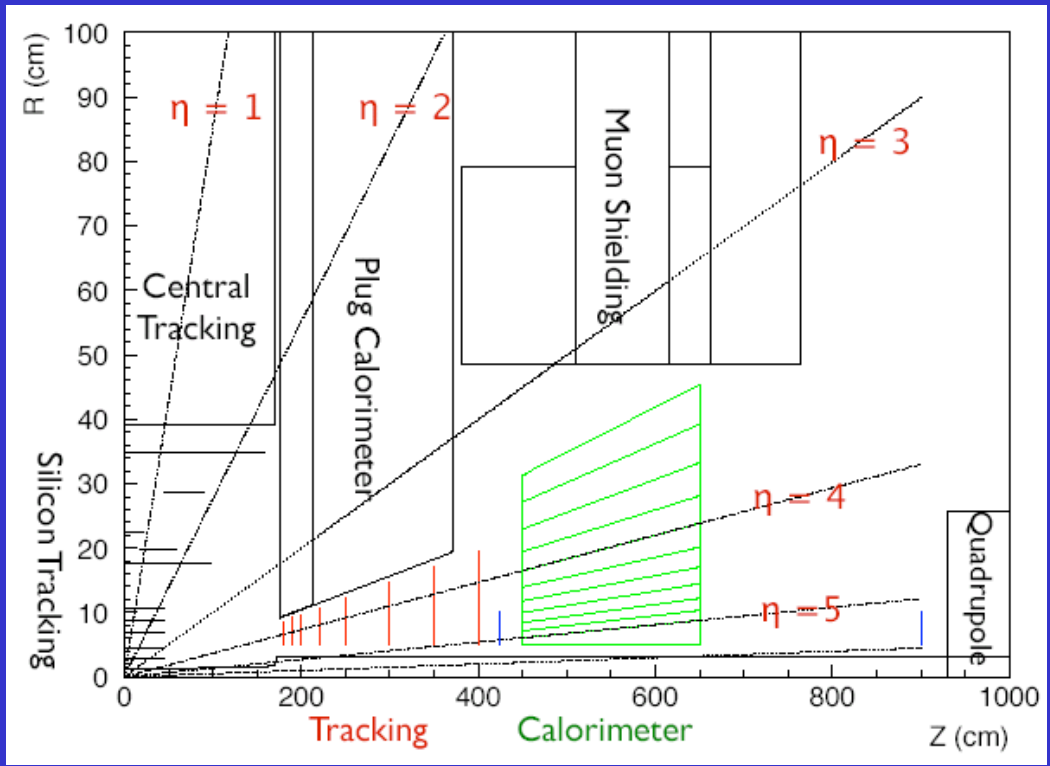
Forward "Cone" Spectrometer for CDF?

$0.5^0 < \theta < 3^0 \Rightarrow 3.6 < \eta < 4.9$

Now: luminosity counters + 1.1 interaction length calorimeter

Possible upgrade:

→ Tracking (in mag field)
→ electrons & photons
→ hadron calorimetry – jets
→ muons

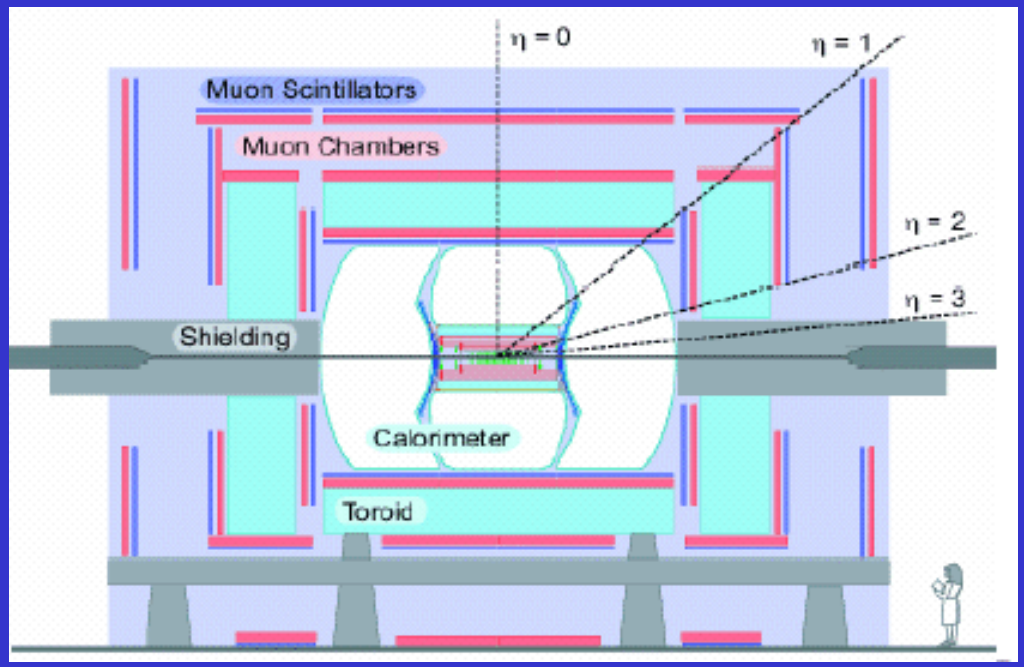


Could be done if sufficiently motivated (and funded!)

& Beyond CDF?

D0 Detector

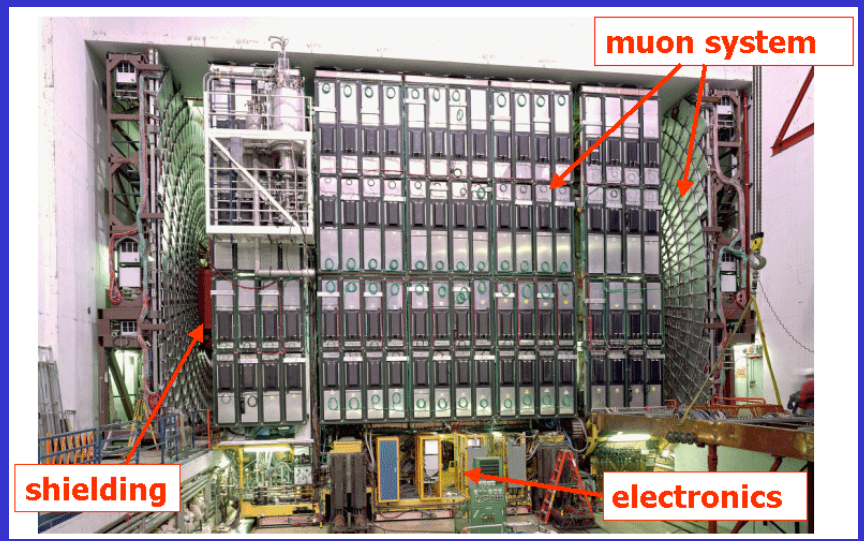
Tracking (incl. muons)
+ L.A. Calorimeter



For Run II added:

Solenoidal field
Silicon tracking
Scintillating fiber tracking
Roman pots with fibers

Possible mini-upgrade:
Roman pots beyond dipoles
on both beams



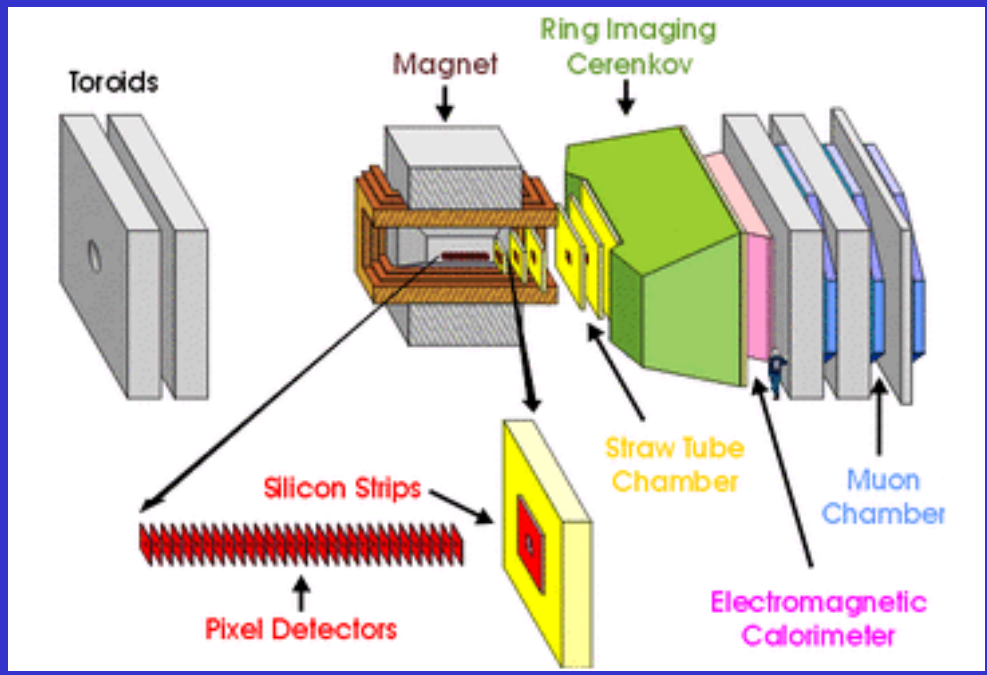
BTeV: B Physics at the Tevatron

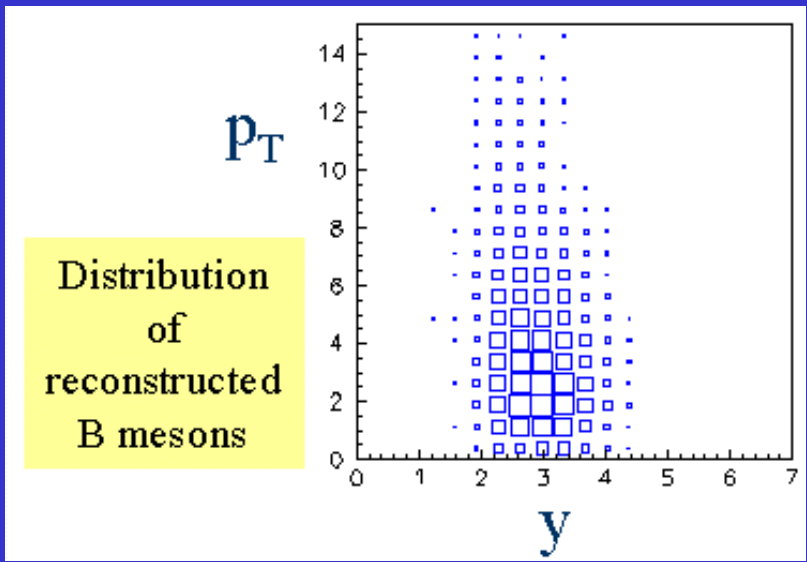
2009 →

Primary motivation:
CP-violation and mixing in
b- and c-sectors

But good QCD capability.

Excellent tracking, vertexing,
particle ID: h, e, γ, μ





Could add: hadron calorimeter for jets,
veto counters for gaps,
roman pots for diffraction ...
Second arm?

Beam is at 7.5

The Future of QCD at the Tevatron

Workshop May 2004: **http://conferences.fnal.gov/qcdws/**

Very active program will continue → > **10 x statistics**
CDF and **D0** detectors stop detecting in 2009 (probably)
Before:
Could add **precision (Si) roman pots** on both sides
Could upgrade CDF very forward **(cone spectrometers)**
Special running: root **s-scan** (630 – 1960), low **B-field** run

BTeV: Supplement B-physics program with more QCD studies:
+ roman pots, hadron calorimeter, veto (rap-gap) counters, + ?

Plan: **"Yellow Book"** on physics issues (cf **LHC, HERA** etc)
Fred Olness, Mark Strikman, MGA eds

TeV4LHC Workshop 2004-5: QCD ... Diffraction and Forward Subgroup

The Future of QCD at the Tevatron ---- May 2004

http://conferences.fnal.gov/qcdws/

Time	mins	Speaker	Institute	Talks
Wed 4:00	60	Mark Strikman	PSU	Colloquium: Looking Forward in QCD
				Meet at Users Center for reception
Thur 20th		**Chair: Mike Albrow**		
9:00	5	Mike Albrow	FNAL	Welcome & Introduction
9:05	30	John Collins	Penn State	QCD Foundations of Monte Carlo Event Generators
9:35	30	Andrew Brandt	UTA	Diffractive results and plans in D0
10:05	30	Vivian O'Dell	FNAL	Jet Physics in D0 and CDF
10:35				**Coffee**
11:00	40	Dino Goulianos	Rockefeller	CDF Run II Diffractive Program and Beyond
11:40	30	Koji Terashi	Rockefeller	Exclusive Production
12:10	25	Christophe Royon	Saclay	Future of QCD at the Tevatron
12:35				**Lunch**
		Chair: Andrew Brandt		
1:05	25**	Albert de Roeck	CERN	Diffraction at LHC with CMS,TOTEM and ATLAS
1:30	25	Cyrus Taylor	CWRU	TOTEM
1:55	25	Mike Albrow	FNAL	Introduction to GTeV
2:20	20	Carl Schmidt	Michigan St.	Forward Jet Physics
2:40	20	Xiaofei Zhang	Kent State	Small x and Q
3:00	15	Rick Tesarek	FNAL	Cone Spectrometers : Introduction
3:15	20	Jun Miyamoto	Purdue	Micropatterned gas detectors
3:35				**Coffee**
4:00	30	Michele Gallinaro	Rockefeller	Calorimetry in the Cone Spectrometers
4:30		Idr Fred Olness	SMU	Discussion on Physics
		Idr John Collins	Penn State	
5:30				End of Discussion

Fri

Fri 21st		**Chair: Cyrus Taylor**		
8:30	40	Rajendran Raja	FNAL	QCD Physics with MIPP
9:10	30	Bernd Surrow	MIT	QCD Physics at HERA
9:40	20	Wlodek Guryn	BNL	Elastic Scattering and Forward Physics at RHIC
10:00	20	Sasha Pronko	U.Florida	Gluon jet fragmentation
10:20				**Coffee**
10:45	30	Brian Cox	Manchester	Exclusive Production of Higgs and exotics
11:15	15	Christophe Royon	Saclay	Simulation of Diffr Higgs at LHC
11:30	20	Mike Martens	FNAL	Tevatron Issues and High Field Dipoles
11:50	15	Yuri Alexahin	FNAL	Tevatron lattice and BTeV compatibility
12:05				**Lunch**
		Chair: Rick Tesarek		
1:00	20**	Tuula Maki	Helsinki	Missing Mass Resolution and acceptances
1:20	20**	Matti Ryynanen	Helsinki	Microstation Mechanics
1:40	20	Helio da Motta	CBPF	Roman Pot Mechanics
2:00	15	John Swain	Northeastern	Avalanche Photodiodes
2:15	10	Jim Pinfold	Alberta	Precision Timing in Pots
2:25		ldr: Rick Tesarek	FNAL	Discussion on Technology
		ldr: Helio da Motta	CBPF	
3:30				**Wine & Cheese**
4:00	60	Dave Soper	Oregon	Diffractive Hard Scattering: What have we learned?

Sat

9:00	15	Jim Pinfold	Alberta	The Cosmic Ray Connection
9:15	25	Harry Cheung	FNAL	QCD Physics with BTeV
9:40	15	Greg Snow	Nebraska	S-scanning
9:55	20	Dennis Weygand	JLab	Hadron Spectroscopy at JLab
10:15	15	Michael Murray	U.Kansas	Gluon Sheets at RHIC
10:30				**Coffee**
11:00	20	Dmitry Litvintsev	FNAL	Hadron Spectroscopy
11:20	60	ldr: Mike Albrow	FNAL	Discussion GTeV plans: towards a proposal
		ldr: Andrew Brandt	UTA	
12:20				**End of Workshop**

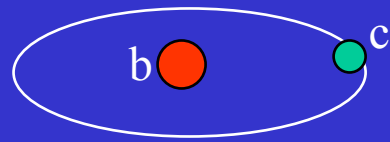
What do we need to do? (~ 5 year time-scale)

High E_T, M_{JJ} frontier — **Gain slow, LHC take-over**

Lower $p_T \Rightarrow$ large distances — **Low B runs, roman pots at small t**

More statistics - but *precision* tests limited

e.g. $B_c = b\bar{c} + \gamma$'s spectroscopy

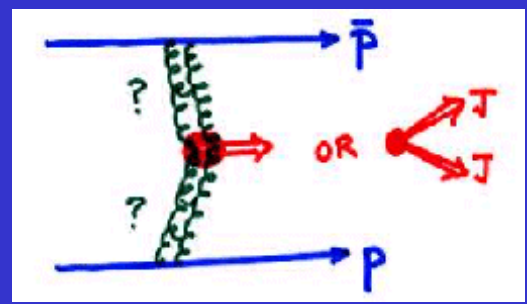


understand jets, for jet spectroscopy $\Rightarrow$ t, H

WW and ZZ pairs — **LHC take-over**

Diffractive sector, especially:

DPE (G, hybrids, hyperons, χ, jets, b-jets)



Very forward production

"Let a Hundred Flowers Bloom" approach

There is spare real estate at C0 with collisions for free.
There could be collisions also elsewhere (at some cost)
Beyond BTeV all options are open.
Detector technology advances, not always exploited.

Example:
Use some high field dipoles → much longer straight sections
Sophisticated MPS = multiparticle spectrometer (~ hi-tech MIPP)

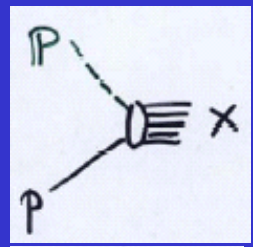
$$\pi^{\pm}, K^{\pm}, p, \bar{p}, s(\ldots\Lambda,\Omega), c, b, \ldots\{bcs\},\{bbc\},\ldots$$

$$0.05 < x_F < 1.0 \qquad p_T = 0 \rightarrow \text{few GeV/c}$$

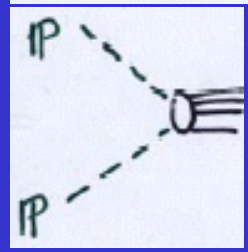
Unexplored territory & very rare states, including $\bar{d}$, $\bar{t}$
Maybe some "small" specialised experiments?

Low mass "Vacuum Excitation" a.k.a.Double Pomeron Exchange

Diffractive Excitation of the proton

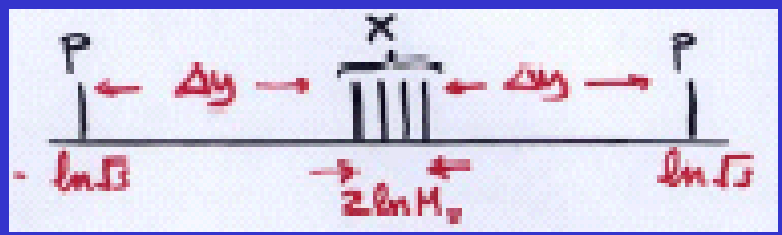


Diffractive Excitation of the 'vacuum'



ANY strongly interacting virtual state in the vacuum can be made real by hh (any h) collision (4-p conservation)

Minimum rapidity gap for pomeron exchange dominance ~ 3 units

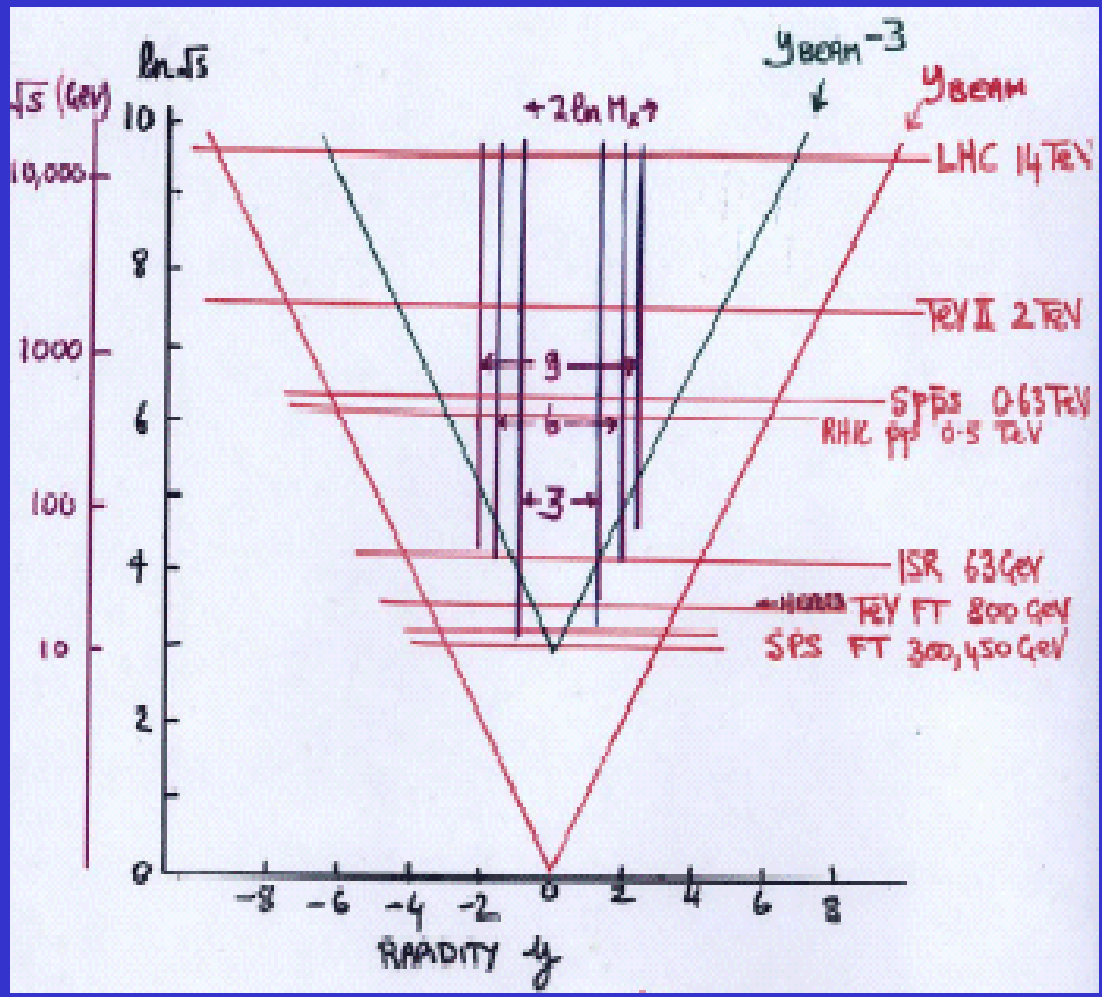


$$\Delta y(symmetric) = \ln\sqrt{s} - \ln M_X \approx 3$$

DPE Mass Range, Different Machines

$$y_{BEAM} = \ln \frac{\sqrt{s}}{M_p} \; ; \; y_{CEN} \text{ spans } 2 \ln M_X \; ; \; 3 \text{ units GAP}$$

Tevatron is the perfect place for low mass DPE.
RHIC (pp) is next best.



Why at Tevatron?

Highest sqrt{s} studied = 63 GeV (ISR) ... just OK < 3 GeV

ISR data limited to $\pi^+\pi^-$, K^+K^-, $p\bar{p}$, 4π

Important: χ_c,χ_b states (spectra vs t_1,t_2,$\Delta\phi$)

$\phi\phi \rightarrow 4K$, $K^+K^-\pi^+\pi^-$, states with η's, etc

$\Lambda\bar{\Lambda}$, ... $\Omega^-\bar{\Omega}^+$, ... $\gamma\gamma$ exclusive and inclusive

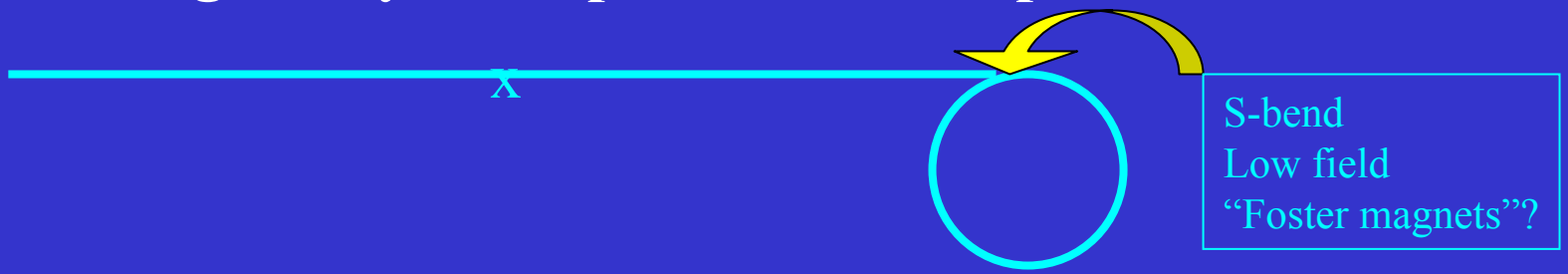
I^G	J^{PC} (DPE)	
0^+	0^{++}	←
0^+	0^{-+}	} Not at 0^0
0^+	1^{-+}	
0^+	1^{++}	
0^+	2^{++}	←

Could be major program using Tevatron as "glue-glue collider"
Not being done in CDF because no (high-x) roman pots & priorities
Will be done in (I think very) limited fashion in D0
Some could be done in BTeV (but not very central)
No LHC experiment can do this (?) [ALICE? Trigger?]
But it does not like high L even though some channels are rare
... want <n/x> ~ 1 for clean events. (3E31) ... more bunches?

Other non-neutrino uses for PD → "Tevatron"?

TeV beams for fixed target physics?

Store high intensity p-beam, bring ILC "500 GeV" e-beam into collision for ep. Defines ILC site (+snake transfer line). How to get very small p beam size at ep focus? What Lum?



ep could be very interesting: ILC+TeV or HERA or LHC

Eventual injector for VLHC? Tevatron will be very old, will probably want to put new higher field ring in tunnel.

Conclusions (?)

There is a **lot of physics** (mostly QCD) to do, even after 2009

New QCD ideas can be implemented in CDF, D0 and BTeV

Unlikely that the big CDF/D0 detectors will run much beyond 2009 without a phase transition in enthusiasm for QCD **(Nobel for IR QCD?)**

Smaller collaborations, detectors, could develop (cone spectrometers +)

Hard to identify in 2004 physics needing high-L in 2014 that is exciting enough to make a case (I suppose making **anti-Helium** is not enough!)

Things can change!